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I. *A few Observations in Mimicry.* By W. J. KAYE.

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PLATE I.

AT the present time, when so much doubt is being cast on the theories of Bates and Fritz Müller concerning Mimicry, it would be as well to put on record some observations that have come under the notice of the writer, and to illustrate the insects concerned with a plate of figures. The drawing of the latter has been done by Mr. Horace Knight, and it is largely to his skill that many who cannot possibly see the specimens will be able to form an idea of some of the extraordinary resemblances. But the object of the present paper is primarily to record the habits of the mimicking insects, and to point out that they are quite abnormal in the family to which they belong, and must have been developed for a specific purpose. All the mimics are members of the family *Syntomidae*, while the models consist chiefly of *Hymenoptera aculeata*, but also *Coleoptera*, *Hymenoptera terebrantia*, and in a single case to another lepidopteron. There are many who, while disbelieving in mimicry generally, yet half believe the action of mimicry when between such widely differing insects as those of the *Hymenoptera aculeata* and the *Lepidoptera*. The theory of Bates then seems as if it might be true, for it is obvious that a stinging wasp must be unpalatable, while by comparison a small moth might well be palatable

and escape under the guise of the model. To those naturalists who have lived in tropical or subtropical S. America, instances of mimicry between the Syntomidae and Hymenoptera, Coleoptera, Diptera and others, are constantly coming to notice. But very few cases have been figured of the models with their mimics. It is to be hoped, therefore, that the present small collection of cases will be useful as well as interesting to those who are interested in these extraordinary resemblances and the reasons that cause them.

The altered habits of some of the *Syntomidae* are most striking, for when we remember the very different ends to be obtained by a ♀ wasp and a ♀ moth there can be nothing really in common. The wasp is predatory and kills all sorts of insects to provide food for the resultant larvae from the eggs she lays, but the female moth merely lays her eggs on a suitable plant or shrub. Any habits, then, that the moth has that are wasp-like are certainly not directly useful to the species concerned except in the way of imitation which quite conceivably deceives its enemies. That there is a reason for these resemblances is universally admitted, and in the cases of moths being like various species of the *Hymenoptera aculeata* it is impossible to argue that the same environment and general conditions can produce habits in moths which are of no use whatever to them except as a disguise. But if the moths themselves were not like the wasps one might argue that it was accidental that the habits were so alike, but the general appearance and structure are in conjunction with the habits so alike that in the species of *Pseudosphex* it is impossible to distinguish moth from wasp on the flower-heads of *Ageratum conyzoides* unless one is within eighteen inches or so, while on the wing at any distance it is quite impossible to distinguish them. But while the species of *Pseudosphex* are mimics of the highest degree, vast numbers of other *Syntomidae* are only very slightly less perfect in their resemblances and habits. Species of the genus *Macrocneme*, although always distinguishable to an entomologist, are wonderfully like members of the genera *Salius* and *Pepsis* of Pompilid or fossorial wasps. The rapid vibrating of the wings, and the waving of the antennae when alighted on a leaf or on the ground, is a most noticeable habit in a moth, which at once recalls the motions of the Pompilids. It should be mentioned also that species of *Macrocneme* do

not often settle on flowers, but like the fossorial wasps settle on the ground, on a bank, or on a leaf, places identical with where the Pompilid wasp settles. As to whether such cases of mimicry are Batesian or Müllerian in their origin is probably not difficult of solution. It seems reasonable to suppose that the former is the explanation, for a powerful stinging wasp is not only unpalatable, but is actually dangerous to an attacking enemy, while the moth is harmless and must by comparison be even palatable. But Müllerian mimicry for its working presupposes experimental attack on model and mimic alike. In such a case as a stinging hymenopteron for a model it is unlikely that experimental attacks could be numerous enough, if they occurred at all, to affect to any appreciable extent its numbers. As soon as the young bird was old enough and able to catch insects and feed itself would it not instinctively leave wasps alone, seeing that all wasps can sting and to that extent at least be unpleasant ? Instinct is a real thing, which Lloyd Morgan has so pithily expressed as follows : " Instinct depends on how the nervous system is built through heredity." Now, with the lepidoptera as food for birds, instinct as to which are good and which are bad probably does not count to any appreciable extent. Experiences are varied and the nervous system is probably affected in a very complex fashion, so that anything definite is not transmitted by heredity, such as must be concerning the edibility of wasps.

Details of the Insects figured.

Fig. 1 represents *Trichura grandis*. This fine species was described by me after I had observed and taken it near Santos in February 1910. It flew and alighted just like a large wasp. The only specimen that I was able to catch was flying along a path in the forest, and several times I noted it settling on the ground, and finally it was observed settled on a leaf vibrating its wings when it was taken. Unfortunately no wasp was taken that could be claimed to be its model, but at that time (Feb. 27th) the species was only just beginning to appear, as Mr. Dukinfield Jones took a series later on, but did not specially look for a model. The habits of several species of *Trichura* are identical in the manner of flying low down along a path and settling on the ground. At the same time and place *T. dixanthia* was so observed, and the remarkable tail to the abdomen

was quite conspicuous. This remarkable structure recalls the ovipositor of a parasitic hymenopteron, but no such possible model was observed.

Fig. 4 is *Pseudosphex noverca*, Schs., and fig. 4*a* is the model *Polybia nigra*, Sauss., a Vespid wasp. This Vespid was not taken by me with the *Pseudosphex*, but Mr. C. Schrottky has taken the two together on *Ageratum conyzoides* in Paraguay. This same plant, which is very abundant in S. Brazil and Paraguay, always attracts a large number of Syntomidae, as well as wasps of both the families *Vespidae* and *Eumenidae*. It was on this same plant that the *Pseudosphex* was taken together with a Eumenid wasp, *Zethus binodis*. The mimicry of these two is remarkable even when they are sitting together as I found them, but the Vespid species *Polybia nigra* is even better, and it is most probable that it also occurs where I took the Eumenid at Fernandez, for it has a wide range. The wonderful special development of the *Pseudosphex* is first of all worth describing. First there are the antennae, which in the stout pectinated portion are just about the length of the wasp's antennae. The fine thread-like tip to the antenna of the Syntomid is hardly visible except one is looking very close. In the figure the pectinations end too gradually, the specimens showing that the pectinations end rather abruptly, giving the antenna at a short distance the exact build of a wasp's. This characteristic is shown better in fig. 5 of *Pseudosphex jonesi*, but even then the thread-like end is not fine enough. The very marked constriction of the basal segments, the very smooth scaling of the head, thorax and abdomen and the colouring of both wings, thorax and abdomen altogether makes these moths most wasp-like. In all of them, also, the profile view of the head is remarkable, for the palpi are densely scaled on the first and second joints, so that the strong jaws of the wasp are most completely imitated. In profile the general resemblance is most complete, for in *every* way there is imitation of the wasp. When viewed above only, is the larger head of the wasp distinctive.

The habits of the species of *Pseudosphex* are equally remarkable with their structure. Of the four species figured no less than three, *P. novercida*, *P. noverca* and *P. polybioides* (figs. 3, 4 and 6), occurred together at Fernandez, while the fourth, *P. jonesi* (fig. 5), was found at Alto da Serra. All the species were found to visit the flowers of

Ageratum in the early morning sunshine before the sun had gained much heat. They then alighted with wings held back over the abdomen and then slightly lowered them downwards and outwards; but to complete the resemblance on the flower-heads these several species of *Pseudosphex* greatly curve their fore-wings while the hind-wing is folded up, so that the wings appear to be as narrow as the completely folded wings of the *Vespidae* and *Eumenidae*. A further habit that was observed by Mr. Dukinfield Jones when with me was that in the case of *Pseudosphex jonesi* he saw that species move its abdomen in and out in just the way that a wasp does, especially when about to use its sting. The several species of this remarkable genus when disturbed flew off the flowers rapidly, and it was impossible for one to follow the flight. The several figures of these moths and wasps with folded wings are unfortunately not quite shown correctly. The artist has drawn them all to show the complete wings, whereas all the specimens show the strong curving of the fore-wing in the case of the moths and folding in the case of the wasps. Figs. 3 and 3*a* represent an undescribed species of *Pseudosphex* which I propose to call *Pseudosphex novercida*. In the Entomologist for 1911, p. 142, I described a species as *P. polybia* which by an error was the already described *Pseudosphex noverca*, Schs.

Pseudosphex novercida, nov.

Very close to *Pseudosphex noverca*, Schs., but differs in the following respects. It has vein 2 of the fore-wing from close to cell while *noverca* has it from long before the end. The white-edged valve on the underside of abdomen is followed by a white band, which is not present in *noverca*. Above, the wings are darker and more sooty in appearance, but the dark scaling does not extend beyond the cell as in *noverca*. In the hind-wing the cell is completely occupied with smooth dark scales while in the case of *noverca* it is only the upper part of the cell that is so scaled. In shape rather less rounded in outline with both fore- and hind-wing slightly narrower. The femur of the front pair of legs is black while *noverca* is white.

Habitat. Fernandez Pinheiro, 12. iv. 10. (*W. J. Kaye*), Castro (*E. Dukinfield Jones*).

Fig. 2 is another new species closely allied to the common *Sphecosoma melissa*, Schs., but abundantly distinct in many ways. I propose calling it

Sphecosoma melissina, nov.

Palpi orange. Frons white. Collar orange. Thorax black and orange striped. Abdomen with the first three segments like the thorax; 4th segment almost wholly black: 5th, 6th and 7th segments darker orange with a central black line: anal segment black. First and second pair of legs with the tarsal joints blackish below. Hind-legs wholly orange above and below. Antennae black. Forewing yellowish hyaline with the costa slightly and with the inner margin broadly at base orange. Costa beyond middle of cell narrowly black. Apex black. Inner margin narrowly black slightly widened at vein 2. Hind-wing yellowish hyaline. The cell with some orange scaling and anal angle with some black scaling up to the basal vein.

Exp. 23 mm.

Habitat. S. Brazil: Guaruja, Santos, 27. ii. 10, several specimens (*W. J. Kaye*).

Fig. 7 represents a *Correbidia*, while fig. 7*a* is its model *Calopterum braziliense*. Both insects were caught together on a very dwarf-growing species of *Ageratum* with small white flowers on 27th Feb. '10. The specimen figured of the Coleopteron is not the specimen that was taken, but is a specimen of the same species from Rio Janeiro. The species is very variable, and if one had taken a number of the insects at Guaruja it is highly probable that one would have secured a specimen exactly like the moth. The difference in the specimen figured of the *Calopterum* and the single example taken is that the Rio specimen has more black on the base of the elytra. It has been figured in preference also because it is in a perfectly natural position and so corresponds with the Syntomid, which also is in a perfectly natural position of rest.

The similarity of these Lycid beetles with Syntomid moths has been noticed by several writers. The heavily pectinated antennae with the pectinations carried to the tip strongly suggest the stout-jointed antennae of the beetle. The abdomen is rather flattened like the beetle, while the shape, colour and manner of folding of the wings is most suggestive of the beetle, while finally the legs are short and correspond with the legs of the Lycid. The habits of these two totally different insects are extraordinarily alike. They both sit on flowers in the early morning, and both drop off if alarmed and draw the legs in. At such times (early

morning) neither show a disposition to fly, but are extremely sluggish.

Fig. 12 of *Pterygopterus caeruleus* with fig. 12*a* of the Pompilid wasp *Salius kirbyi* affords a striking case of Batesian mimicry. The very dark blue-black wings with the smallest amount of lustre, the conspicuous yellow antennae and the long hind-legs of the fossor are most completely copied in the ♀ Syntomid moth. Both fly together in the forest near the Potaro River above the Tumatumari cataract in Central British Guiana. The wasp is common and flies heavily, carrying its antennae and hind-legs almost as shown in the figure. The first and second pairs of legs are carried more folded to the abdomen. The moth is a rare species, and only the one specimen was taken by Mr. C. B. Roberts, who was collecting in the same locality for six years. I am unable to say anything as to its habits, but it is highly probable that it carries its long hind-legs stretched out behind in the way the wasp does, in the same way as members of the genus *Macrocneme* do, and as is shown in the case figured of *Macrocneme adonis* (fig. 13).

Figs. 13 and 13*a* is another case of a Syntomid moth mimicking a Pompilid wasp. In this instance the two insects, *Macrocneme adonis* (fig. 13), *Pepsis* (fig. 13*a*), occur together towards the end of May in the wooded ravines at about 3,500 ft. on the coast range of mountains at Caracas, Venezuela. Flying at the same time is another species of Syntomid *Macrocneme lades* (fig. 14). In some lights this species looks very much like the *Salius* even in the cabinet drawer, while in flight it is almost as much like the wasp as *M. adonis*. When the sunlight falls on the wings of the wasp *M. adonis* is the better mimic, but in shade *Macrocneme lades* and *Macrocneme adonis* are hardly distinguishable, and both are equally good mimics. The habits of these *Macrocneme* species are extremely interesting. They carry their hind-legs extended in imitation of the wasp. They alight on leaves or settle on the ground, and do not frequent flowers. When settled on a leaf they vibrate their wings while in the position as is shown in fig. 14. They also wave their antennae, all of which are characters of the " marabunta " as these wasps of the genus *Salius* are invariably called locally. Fig. 14 is a specimen of *M. lades* from S. Brazil, and it was drawn purposely to show the position in which the species alights with the wide

space between the wings. In the specimens of the same species from Caracas the white spots at the base of the abdomen are very greatly reduced, and in one ♀ hardly traceable at all. In S. Brazil, at Castro in Parana, I found *M. lades* (= *leucostigma*) commonly, yet wasps of the genus *Salius* did not appear to be present. This was in March and early April. But Mr. E. Dukinfield Jones, who resided for many years at Castro, informs me that these fossors are quite common at different times of the year, only they usually occur but singly.

Figs. 10 and 10*a* represent a most interesting case of mimicry from the Potaro River in British Guiana. Fig. 10 is of the Syntomid moth, *Sphecosoma testacea*, and fig. 10*a* is of a small Pompilid or fossorial wasp, *Batazonus polistoides*. Neither of these species I have seen alive. Mr. C. B. Roberts, who collected for some years for me after I left the Potaro district, sent the wasp as a Syntomid moth along with several of the *Sphecosoma testacea* and with a still greater number of a closely allied species (but not figured on the plate) *Sphecosoma angustatum*. Although the latter is considerably the commoner species, *Sphecosoma testacea* is more like the wasp as it shows the darkening of the costal area, which is a character agreeing with the wasp, while the commoner *S. angustatum* does not exhibit this character at all. The wasp was sent on 25. iii. 05, and specimens of *S. testacea* were sent in January, April, May and June. Examples of *S. angustatum* were sent in March, April, May and June. Two specimens of the very similar *Pseudosphex polistes* were also sent in April and May 1904.

Fig. 8 of *Rhyncopyga braconida* and fig. 8*a* of a species of *Braconidae* are figured together to show many points of remarkable similarity. The two insects were not caught together, but at approximately the same time of year and at the same elevation, and it is possible and quite probable that they could be netted together. The moth *R. braconida* I took on March 6th, 1910, at Alto da Serra above Santos at 2,500 ft. The Braconid I netted on 4th April, 1910, at Castro at 2,900 ft. At Castro, however, on 14th April I took another species of *Rhyncopyga*, viz. *meisteri*, which is very similar but has the first four basal segments red below, while the species figured has the two basal segments banded red. Either species forms almost an equally good mimic, but as the one illustrated is new it seems more desirable to figure it than the commoner and better known *meisteri*.

In the case of the species figured, attention should be drawn to the long thread-like antennae; the long black legs and the colouring and markings of the wings, which all suggest the Braconid, while on the wing one is deceived, without previous experience, by the very similar flight and attitudes. I myself caught the Braconid on a flower, where its ovipositor was concealed, thinking it was a species of the Syntomid genus *Rhyncopyga*. It is quite possible that this Braconid might be parasitic on the *Rhyncopyga* except that in size it is rather too large.

Fig. 11 of *Callopepla inachia* ♀, a Syntomid, with fig. 11*a* of *Scea auriflamma*, an Oenochromid, represents a remarkable and very interesting instance of convergence. As will be seen from the figures the two moths are very much alike in colouring and scheme of markings. The ♀ Syntomid must have been influenced by the Oenochromid, because the ♂ of *C. inachia* is quite different, with a brilliant blue hind-wing and fore-wing, with red apical band and basal streaks. The ♀♀ vary greatly from having a reddish orange band on fore-wing with orange basal streaks and hind-wing with shot-blue scaling at the base, to the form which is figured with an extension of a yellow band inwards to the base and the hind-wing with but a trace of blue scaling. The habits of these two insects are, however, quite divergent; the Syntomid flies briskly in the early morning sunshine and is fond of settling on various compositae, such as Eupatorium and Ageratum, while *S. auriflamma* haunts shady woods and flies quite slowly. Both insects when at rest fold their wings flat over the abdomen, the Syntomid scarcely making the inner margins of the fore-wing meet, while the Oenochromid makes them meet closely. In relative abundance the *S. auriflamma* is by far the most abundant and is also more generally distributed. We found it on the Corcovado at 1,000 ft. at Rio, where *C. inachia* was absent. We also found it at Alto da Serra, where also *C. inachia* was absent. But at Castro and Fernandez Pinheiro we found both in the months of March and April, but always in their own special haunts.

The last case of figs. 9 and 9*a* will have puzzled those who looked at the plate to see the resemblance. Fig. 9 is of the common Syntomid *Paraethria triseriata*, and 9*a* is of the Coleopteron *Astylus antis*. On March 11th, 1910, at Castro in S. Brazil, I came on a bush in flower which had myriads of the coleopteron flying round it. The sight

was so unusual that I stood gazing at it for a few minutes, when I suspected two of the beetles of being moths. After a little manœuvring I netted these two strangers, and they turned out to be *Paraethria triseriata*. That there was a very real resemblance when these insects were flying together in the sunshine must be taken on trust, for from the figures of the dead specimens it seems almost impossible that any real resemblance could exist. The figure of the moth, however, is unable to show the shot metallic green abdomen which can be most obviously seen by holding the specimen in strong sunlight. The light-yellowish costa of the hind-wing, which shows through the fore-wing as the specimen is illustrated, can but be imagined to give the banded appearance that the beetle has got. The white spots on the abdomen certainly did not present themselves in rapid flight, and the wings in some lights, like so many of the Ithomiinae, are a strong blue. Confirmation of this observation is much to be desired, for it is furthest from the writer's wishes to be considered an extremist.

Explanation of Plate I.

[*See Explanation facing the* Plate.]